January 25, 2002

MEMORANDUM TO: Stuart A. Richards, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: Drew Holland, Project Manager, Section 2
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Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF DECEMBER 5, 2001 MEETING WITH WESTINGHOUSE ELECTRIC COMPANY - FUEL PERFORMANCE UPDATE

The Westinghouse Electric Company (W) met with the NRC staff to discuss issues related to their recent nuclear fuel performance experiences. The meeting was conducted at the Westinghouse Fuels Facility in Columbia, South Carolina. The content of this presentation included a fuel performance overview and individual discussions of lead test assembly (LTA)/high burnup (HIBU) programs, use of low tin ZIRLO, computer code methodology consolidation, incomplete rod insertion (IRI) topical report closeout and the control element assembly (CEA)/rod cluster control assembly (RCCA) investigations.

Fuel performance in terms of leaking fuel during each plant's previous cycle was presented graphically. More information was provided on leakage in terms of micro-Curies per gram of Iodine-131. A pie chart was provided that described various leakage mechanisms observed in W plants from 1995-2001 from a population of over 6 million fuel rods. It was shown that W was having good success in its corrective action program to reduce fuel leakage. A summary was provided that indicated that 98 percent of W plants are within the Institute of Nuclear Power Operations (INPO) standard for activity in reactor coolant and 78 percent are zero defect plants.

An update was given on top nozzle spring screw fracture. Test articles from one plant were reviewed along with the basis for their selection. The test objectives included determining the condition of springs and screws, determining the effectiveness of ultrasonic (UT) and spring scale inspection methods, locating cracks in threaded areas and determining force vs. deflection characteristics and total relaxation for springs. Hot cell testing of the top nozzle spring screws showed no cracking in threaded areas. A wide range of screw head fracture was seen. The spring scale and UT methods were reasonably accurate. UT accuracy improved in the hot cell. However, the spring scale is preferred for field detection of nonfunctional joints. Spring characteristics were as expected. Determinations of irradiation relaxation could not be made. W considers that their approach for inspection and repair employs sound risk bases. It was found that shot-peened screws are not susceptible to cracking. Thus far, no loose parts have been determined to exist relative to this topic and no impacts to plant critical paths have been observed.

Next, W described the findings from the North Anna top nozzle separation incident. In this case, the top nozzle separated from a fuel assembly (FA) during routine handling. The parts in question include a welded top nozzle with 304 stainless steel grid sleeves. The cause was determined to be intergrannular stress corrosion cracking (IGSCC). W has implemented a program of identifying and locating susceptible fuel, performing inspections, and reviewing plant chemistry history for a number of plants. W has developed a strategy involving several options for handling susceptible fuel in the future. New tooling may be required in some cases.

The next issue discussed was the Braidwood thimble tube wear root cause investigation. W has developed an inspection and monitoring program in response to this finding. No limitations to operations or fuel handling presently exist for this condition. The problem is more significant in fuel that has been in contact with Hafnium RCCAs. There are no Hafnium RCCAs in service or planned for future use. No instances of through-wall wear have been found in situations involving Silver-Indium-Cadmium (Ag-In-Cd) RCCAs. Some tool design changes for anchor installation may be required. W will continue to monitor for this failure mechanism.

The meeting then shifted focus to the Combustion Engineering (CE) product line. It was explained that 90 percent of the applicable reactors meet the INPO fuel reliability index (FRI) coolant activity goal. Grid-to-rod fretting was described as being the leading cause of fuel failure. However, design improvements are being implemented to increase the fretting margin. Another fuel performance issue is oxide spallation. Grid-to-rod fretting failures have been confirmed in three reactors and is suspected in three others. Oxide spallation has been observed on OPTIN cladding in heavy duty applications at four plants. However, W has developed fuel duty guidelines as a response and employment of ZIRLO has reduced spallation.

The discussion then proceeded to the Palo Verde 2 Cycle 9 fuel failures. In this case an efficient ring core design was used that was similar to types used in prior cores. A mild axial offset anomaly may have contributed to the problem. All affected fuel assemblies (FAs) were scanned at end of life (EOL). The results indicated that there were 10 failed rods among 6 once-burned bundles. Twenty "inner ring" assemblies were discharged as an interim compensatory measure. Comprehensive examinations were performed to characterize failed rods. Crud-enhanced corrosion was hypothesized to be the failure mechanism. Examination results for Palo Verde 1 were also discussed.

CE fuel performance has improved steadily through the 1990's as debris fretting, the leading cause of fuel failures, has been addressed. Programs are in progress or proposed to address other fuel performance issues. These include grid improvements in response to grid-to-rod fretting, implementation of ZIRLO cladding to improve clad performance and a program for crud mitigation.

In the LTA/HIBU program, a total of 14 plants have been involved in various testing. Most of the data in this category is proprietary.

The next topic for discussion was low tin ZIRLO cladding material. It is intended that a complete set of ZIRLO base material properties will be developed as agreed to with the NRC. LTAs will be licensed to all current criteria. Model adjustments will be used as needed to account for changes in material performance and reported by letter in the form of an exemption

request. Regions will be licensed to all current criteria or to new criteria which will be justified and compared to test data. Information will be submitted for review and approval in a revision to WCAP-12610-P-A to expand the ZIRLO definition to cover the low tin condition for region introduction.

The code/methodology consolidation presentation began next. At the present time, there are three different sets of neutronics lattice and nodal codes. The focus is to develop a single code package for W, CE and Atom product lines. There are five sets of fuel rod performance codes that also need to be integrated. Data from the high burnup programs will provide needed information. The work will be coordinated through the next generation fuel (NGF) project.

The next item to be discussed was the Westinghouse Owners Group (WOG) IRI program. In November 1997, the NRC provided the industry an opportunity to take the lead on IRI. In January 1998, the WOG issued an IRI position paper to provide a long-term process to resolve and close the IRI issue. The position paper addressed three key points: (1) establishing burnup screening thresholds based on current fuel data; (2) development of new design features and tools available to reduce the potential for IRI; (3) at that time, additional high burnup FA drag data was needed to provide statistical confirmation to prevent future IRI events and to allow increasing screening thresholds to the currently licensed burnup limits if possible. Drag data has been collected and analyzed from over 104 additional bundles. This led to the issuance of WCAP-15712, "IRI High Burnup Threshold Program." One of the conclusions of the program was that the additional drag data statistically fit with the previous data. In addition, FAs with 1.1" bottom nozzle rod gap (BNRG) tend to have higher total drag. A larger BNRG keeps thimble tubes in compression (e.g. fuel rods not in contact with bottom nozzle) which could lead to thimble tube bow and high FA drag. FAs with ZIRLO guide thimbles and a BNRG of 0.465" or 0.085" (which is the majority of product in use) have significantly less total drag. Smaller BNRGs cause thimble tubes to be less compressed due to expected fuel rod growth. The bases for the closeout of this issue include design features being incorporated that reduce the potential of IRI.

Among these features are intermediate flow mixer grids, thicker thimble tubes and smaller BNRGs. The new drag data was consistent with the previous data. A statistical analysis confirms that the WOG guidelines are conservative.

The presentation moved next to the status of Palo Verde control element assembly (CEA) failures. CEALL (computer code) had predicted irradiation assisted stress corrosion cracking (IASCC) in Cycle 9. Cracked components were found at the end of Cycle 9. As a result of this finding, the licensee replaced all full strength CEAs. A variety of failure modes were detected in all three units. A 10 CFR Part 21 evaluation of the issues was closed with a negative finding. However, a root cause analysis team has been formed and work is in progress. The following conclusions/observations were made: (1) all three units are operating at full power; (2) CEALL predicts that IASCC margin will exist at the end of Unit 3 Cycle 9 and Unit 2 Cycle 10; (3) earlier than predicted Palo Verde CEA failures are specific to the interaction between B_4C/feltmetal; (4) information indicates that the B_4C/Ag-In-Cd design is not subject to the same mechanism causing failure in the Palo Verde CEAs, and (5) B_4C/feltmetal is only used in System 80 plants (Palo Verde and Korean). Continuing efforts include: (1) evaluation of potential CEALL non-conservatisms; (2) evaluation of impact on other CE plants; and (3) continued inspections planned for Palo Verde.

The discussion then shifted to the Farley Unit 1 incomplete rod insertion in dashpot (IRID) event. During a recent heatup of the plant, four RCCAs did not fully insert. The RCCAs were original equipment and had been in operation for almost 19 effective full power years (EFPYs). The response to this event was a replacement/testing program at Farley visual examinations, drag testing and drag work analyses. All 17 original equipment RCCAs for Cycle 18 were located in fresh FAs. The FAs and original equipment RCCAs were determined to be the most likely cause of the IRID. Inspections included visual inspections of original equipment RCCA tips, fiberscope inspections of the FA guide thimble tubes and ring gauge measurements of the original equipment RCCA rodlet diameters. Through the W project efforts, it was determined that swelling of the RCCA rodlet tips on the highly irradiated RCCAs was the cause of the IRID event. All 17 original equipment RCCAs were replaced.

Project No. 700

Attachment: Attendance List

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MEETING WITH WESTINGHOUSE

ON FUEL PERFORMANCE UPDATE

DECEMBER 5, 2001

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